Intercontinental Geoinformation Days

igd.mersin.edu.tr

Locational analysis of infrastructural facilities in selected oil and non–oil producing areas of Akwa İbom State

Inyang Mbom. U*[1], Soneye A.S.O [1], Okolie C.J [2] Odunuga, S.S [1] Onyegbula, J.C [2] Akinnusi, S.A[2], Olanrewaju, H.O[2]

[1]*University of Lagos, Faculty of Social Sciences, Department of Geography, Lagos, Nigeria*
[2]*University of Lagos, Faculty of Engineering, Department of Surveying and Geoinformatics, Lagos, Nigeria*

Keywords
Coverage
Geospatial Analysis
Location-Allocation
Infrastructural Facilities
Optimal location zones

ABSTRACT

Location influences Infrastructural facilities' importance, efficiency, and performance. This study involves locational analysis of infrastructural facilities in twenty purposively selected oil and non-oil producing rural communities of Akwa-Ibom State. Coordinates of infrastructural facilities were acquired using a handheld Global Positioning System (GPS) device. Network analysis, infrastructure conformity assessment, and the minimize impedance analysis were carried out using ArcGIS. Results indicated that both oil and non-oil producing regions are within the service area of educational and water facilities, each having seven communities within the commercial infrastructure service area. Most oil-producing regions were within the service area of health facilities, while most non-oil producing areas were within the service area of small-scale industries. The infrastructure conformity assessment showed that 97% of infrastructures in the oil-producing regions were within the optimal location zones while 85% of infrastructure in non-oil producing areas were optimally located. Also, 21.3% and 17.6% of all infrastructures were closest to demand in the oil and non-oil producing regions, respectively. Ability to operationalize coverage issues and use location-allocation modeling optimally was demonstrated. The paper recommends enhanced infrastructure investment in areas outside infrastructure service areas and the use of location-allocation models in service provision to promote equity and spatial balance.

1. INTRODUCTION

In any nation, economic growth and development depends to a large extent on the adequate availability, spatial distribution/location of infrastructural facilities which provides the essential utilities and services necessary for a robust economy and improved standard of living (Udofia et al. 2013). The location of infrastructure has a lot to do with deciding to put an activity in one place rather than another, just to maximize value or to minimize expenses. However, by way of definition, location-allocation modelling is a simultaneous location of central facilities and the allocation of dispersed demand to them so as to optimize some objective function (Goodchild, 1984), where optimality is defined in terms of highest possible access within a given constraint (Kumar,2004).

The distribution and optimal location of Infratsructural facilities is the ease with which these facilities can be assessed and also shows effective planning of these facilities. It is envisaged that the sustainability of the environment and human life may not be successfully achieved until human settlement are economically, socially and environmentally vibrant through adequate provision and optimal location of infrastructures (Udofia et al. 2013).

In the light of Akwa Ibom State being the largest oil producing state in Nigeria and the continual receipt of far greater revenue from the federation accounts than any other states in the country. This study, therefore, integrates the location allocation modelling framework in analysing the existing infrastructures in the study area to ascertain its service area network, its conformity assessment to standard optimal location zones and the minimize impedance analyses of the infrastructures to various demands.

* **Corresponding Author**

*(mbomabasi@gmail.com) ORCID ID 0000-0002-4585-5745

Cite this study

Inyang M U, Soneye A S O, Okolie C J, Odunuga S S, Onyegbula J C, Akinnusi S A, Olanrewaju H O (2021). Locational Analysis of Infrastructural Facilities in Selected Oil and non-Oil Producing Areas of Akwa Ibom State, Nigeria. 3rd Intercontinental Geoinformation Days (IGD), 139-142, Mersin, Turkey

2. Method

The inventory of the identified socioeconomic infrastructures in the twenty communities of study was taken alongside their spatial location (x, y coordinates) with the help of a hand held GPS. Documented records of the existing infrastructures were collected from the Bureau of statistics of the Ministry of Economic Planning and Development, Akwa Ibom State.

2.1 Location allocation analysis

The network analyst toolset on the ArcMap software was used to perform the location allocation analysis. A three-step approach of service area network analysis, infrastructure conformity assessment (circular buffer analysis), and minimized impedance distance location/allocation technique (nearest facility to demand) were used for this analysis.

2.1.1 Service area network analysis

The service area network analysis was used to delineate service areas around each facility. It showed the demand points that fall within the areas serviced by each facility based on the standard distance of 1km for all water facilities as posited by UNICEF and WHO; 1.5km for all school facilities, commercial and small scale industry infrastructures (Menezes and Pizzalato.,2014 and Ayoade, 2014) and 1km for primary health centers and 3km for General/Cottage hospitals (Onokerhoraye, 1982)

2.1.2 Conformity assessment (Circular buffer analysis)

The circular buffer analysis was used to create buffers around each demand points based on a specified standard distance to show how the percentage of infrastructures that conform to the optimal zones. A buffer radius of 1km for all water facilities as posited by UNICEF and WHO,1.5km for all school facilities, commercial and small scale industry infrastructures (Menezes and Pizzalato.,2014; Ayoade, 2014), 1km for primary health centers and 3km for General/Cottage hospitals (Onokerhoraye, 1982) was created set around each of the demands. It showed the count or spatial distribution of the infrastructures that fell within or without the buffers. These buffers created are also considered as optimal zones for siting new infrastructures or reallocating the existing ones

2.1.3 Minimized impedance distance analysis (Nearest facility to demand)

The minimized impedance distance analysis was used to determine the closest infrastructures to each demand points based on a standard impedance distance cutoff of 1km for all water facilities as suggested by WHO and UNICEF (2014), 1.5km for all school facilities (Menezes and Pizzalato.,2014), 1k for primary health centers and 3km for General hospitals (Onokerhoraye, 1982). However, 1.5km was applied for rural markets, banks, and small-scale industries because it shows a regular accessibility distance as posited by Ayoade (2014). The minimize impedance problem technique, also known as the p-Median problem was applied in this study by using the existing infrastructures as candidates and the communities as demands. The aim of the model is to minimize the total distance travelled by residents from demands to access infrastructures.

3. Results

3.1 Education infrastructure

All communities in the oil and non-oil producing areas fall within 1.5km service areas of all educational infrastructures. In the oil-producing area, 100% of the infrastructures satisfied the infrastructure conformity assessment of being within 1.5km optimal location with 21% of it chosen by minimize impedance as closest to all the demand (communities) while in the non-oil producing area, 93% of the infrastructures satisfied the 1.5km optimal location conformity assessment with 25.9% of the facilities chosen as closest (below 1.5km) to eight demands exception of Ikot Essien and Odot 111 with distances of 2.72km and 1.59km respectively. The distances range of the closest facilities to demand is between 0.06km to 0.79km in the oil-producing area and 0.23km to 0.89km in the non-oil producing area, all below the ideal home school distance of 1.5km (Fig.1 and 2).

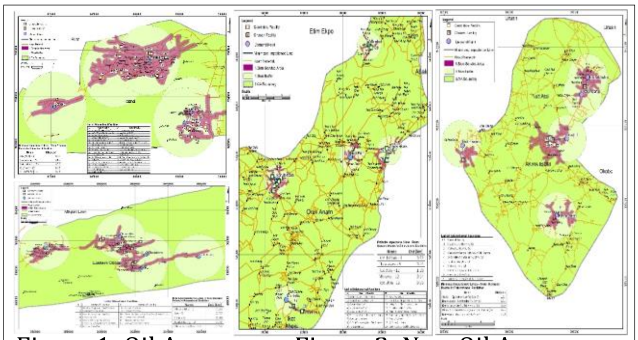

Figure 1: Oil Area Figure 2: Non-Oil Area

3.2 Health infrastructures

Only four communities comprising of Odot111, Okoro Nsit, Ikot Ibritam, and Ekparakwa out of ten in the non-oil-producing area are within 1km service areas of primary health centers with 60% of the existing health facilities satisfying the conformity assessment of being within 1km optimal location (Figure.3) and also chosen as the closest to three demands with primary health centers distances from demand above 1km being indicated for Ikot Adia 11.54km, Mbiakot 10.87km, Ikot Essien 6.68km, Ikot Akpabio 5.48km, Ikot Inyang 4.29km, Ikot Etim 4.85km and Odot 111 1.5km (Figure. 3). Conversely, the oil-producing area has nine (9) of it communities comprising of Mkpanak, Upenekang, Iwuoachang, Okoroutip, Iwuokpom, Okoroette, Iko, Okoromboho and Atabrikang within 1km service area of primary health center, exception of Elile and three communities comprising of Upenekang, Iwuoachang and Okoroette within 3km service areas of general/cottage hospital with 83% of all the existing health infrastructural facilities satisfying both the 1km and 3km conformity assessment (optimal location) and 66.6% facilities closest to nine communities namely Mkpanak, Upenekang, Iwuoachang, Okoroutip, Iwuokpom, Okoroette, Iko, Okoromboho and Atabrikang with only Elile as an exception, having to access the existing general hospital with a distance of 3.12km above acceptable standard distance of 3km. (Figure 4).

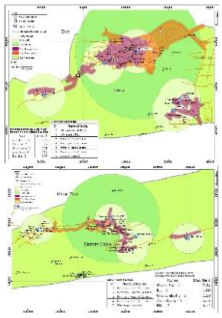
Figure 3: Oil Area

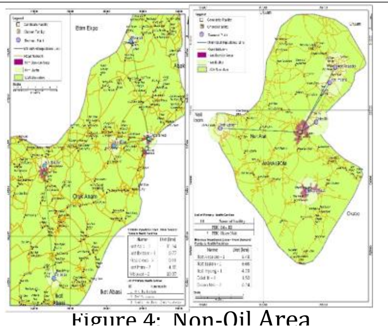
Figure 4: Non-Oil Area

3.3 Water Infrastructure

Both the oil and non-oil producing areas have all its communities within 1km service areas of all existing water infrastructures. Based on optimality of 1km walking distance to water facility, 97% of existing water facility in the oil-producing area satisfies the conformity assessment of being within 1km optimal location zones with 9.9% of it chosen as closest to all demands (communities) while the non-oil producing area has 77% infrastructure conformity assessment (optimality) with 11% of it chosen as closest to demand with distances all below 1km impedance cut-off. This makes the oil-producing area water infrastructure slightly optimally located than the non-oil area (Figure. 5 and 6).

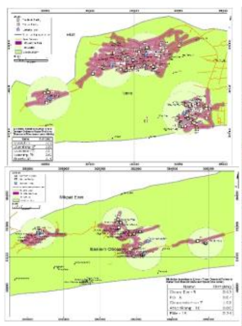
Figure 5: Oil

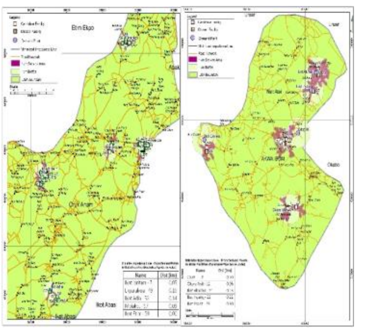
Figure 6: Non-Oil

3.4 Small Scale Industry Infrastructure

The oil-producing area has four of its communities namely Upenekang, Okoroette, Okoromboho and Iko within 1.5km service areas of small-scale industry infrastructures. All, the existing infrastructures satisfied the conformity assessment of being within 1.5km optimal location impedance cut-off and closest to four communities. The communities out of service area with distances to infrastructure above 1.5km are Iwuoachang 3.05km, Iwuokpom 3km, Mkpanak 2.61km, Okoroutip 6.19km, Elile 3.99km, and Atabrikang 3.82km. (Figure. 7). Conversely, the non-oil producing area has 8 out of 10 of its communities within 1.5km service area. They include Odot111, Ikot Essien, Okoro Nsit, Mbiakot, Ekparakwa, Ikot Ibritam, Ikot Etim and Ikot Adia. 95% of the infrastructures conform to 1.5km optimal location and 13% of it are closest to eight communities leaving out Ikot Akpabio and Ikot Inyang, with distances above 1.5km to the existing small-scale industry infrastructures (Figure. 8).

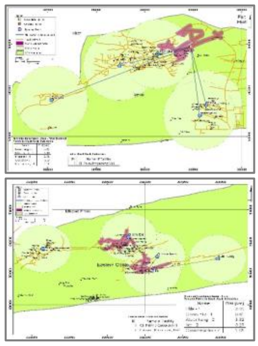
Figure 7: Oil Area

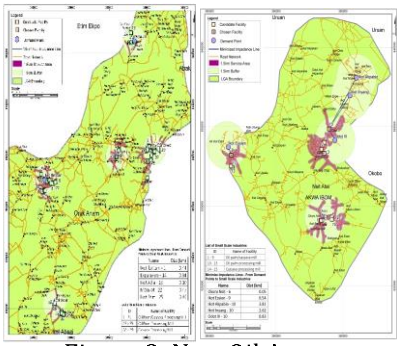
Figure 8: Non-Oil Area

3.5 Commercial infrastructure

Both the oil and non-oil producing areas have seven of its communities within 1.5km service area of existing commercial infrastructures. All the commercial infrastructures in the oil-producing area satisfies the conformity assessment of being within 1.5km optimal location zones and closest to seven demands (communities) namely Mkpanak, Upenekang, Iwuoachang, Iwuokpom, Okoroette, Okoromboho and Iko leaving out Elile, Atabrikang and Okoroutip with 4.73km, 3.90km and 3.92km distances to the infrastructures respectively which are above the standard 1.5km. Also, all infrastructures in the non-oil producing area satisfies the conformity assessment of being within the 1.5km optimal location zone and 77.8% of it were chosen as closest to seven demand (communities) including Ekparakwa, Ikot Ibritam, Mbiakot, Ikot Inyang, Ikot Akpabio, Ikot Essien and Odot111 with exception of Okoro Nsit, Ikot Adia and Ikot Etim which has 4.78km, 12.20km and 5.40km distances respectively above 1.5km (Figure. 9 and 10)

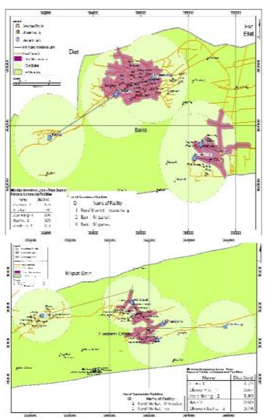
Figure 9: Oil Area

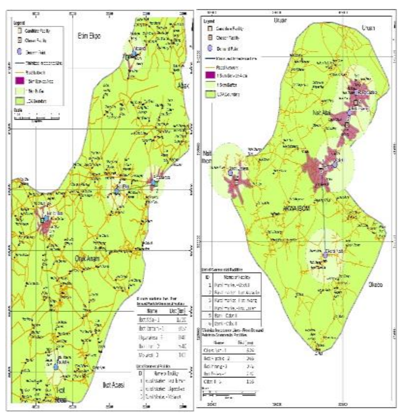
Figure 10: Non-Oil Area

4. Discussion

Provision and optimal location of infrastructural facilities is critical to national development especially when it is distributed in a way that equity and spatial balance are not compromised. Location allocation modelling provides the solution for spatial decision not only in finding the optimal locations for but also acts as tool to determine the coverage and solutions to distances between services and demand points. From the foregoing analysis, it is revealed that all communities in both areas of the study are within the education and water infrastructure service areas. Each of the oil and non-oil producing areas have seven communities within the service area of commercial infrastructure. Most of the communities in the oil-producing areas are within the service area of health infrastructure, while the non-oil producing areas have most of their communities within the service area of small-scale industry infrastructure. Aggregately, 97% of the existing infrastructures in the oil-producing areas are within the optimal location zones, while 85% of the infrastructure in non-oil producing areas is optimally located. Also, 21.3% and 17.6% of all infrastructures are chosen as the closest to demand in oil and non-oil producing areas, respectively.

Generally, although all communities in the oil and non-oil producing areas are within areas served by education and water infrastructures, the oil-producing areas have most of its communities served by health infrastructure. In contrast, the non-oil producing areas have most of its communities located within the small-scale industry infrastructure service area. According to the conformity to optimal location zones, the oil-producing areas are better conformed to an optimal location in the distribution of education, health, water, small-scale industry, and commercial infrastructure than the non-oil producing areas. However, though the percentage of the infrastructures closest to demand in both areas of the study is significantly small, the oil-producing areas have more demands being closed to education and health infrastructure, while the small-scale infrastructure is closest to more demands in the non-oil producing areas. Both areas of the study have an equal number of demands closest to water and commercial infrastructures.

5. Conclusion

It is a recommended practice in facility planning to regularly examine the existing infrastructure pattern and compare it to an optimal pattern. This will allow for a more efficient infrastructure location that could eliminate compromise in spatial balance. Applying the minimized distance option of the location-allocation model framework in this study generated the nearest facility to demand. It is assumed that users will always visit the nearest facility.

This study demonstrates the possibility of operationalizing the many problems of service delivery in development planning. The research findings imply that the continuous reliance on traditional paradigms by decision-makers for service location planning makes it impossible to effectively and accurately assess the degree to which service delivery patterns are consistent with stated goals. In this regard, decision-makers and planners have the opportunity to explore alternative location plans and evaluate their compatibility and consistency with pre-determined goals. These can prove invaluable in redefining the problem, generates new location options, and eventually decide on the best and acceptable plan to use'

References

Ayoade, M. A. (2014). Spatial accessibility to public maternal health care facilities in Ibadan, Nigeria. *The International Journal of Social Sciences*, *26*(1), 13 -28.

Goodchild, M. F. (1984). A location-allocation model for retail site selection. *Journal of Retailing*, *60* (1), 84 - 100.

Kumar, N. (2004). Changing geographical access to and locational efficiency of health services in two Indian districts between 1981 to 1996. *Social Science and Medicine*.*58* (10), 2045 – 2067.

Menezes, R. C., and Pizzalato, N. D. (2014). Locating public schools in fast expanding areas: Application of the capacitated p-Median and maximal coverage location models. *Pesquisa Operational*, *34*(2), 301-317.

Udofia, E. P., Atser, J., and Ikurekong, E. E. A. (2013). Linear discriminate analysis of multiple groups in rural settlement of Akwa Ibom State, Nigeria. *Journal of Rural Development, 32*(2), 121-138.

WHO and UNICEF. (2004*). Meeting the MDG drinking water and sanitation target: A mid- term assessment of progress*. Geneva, Switzerland.